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Contract was a vehicle used by USG customer to procure SCBI initiators, JA2 19-Perf Hex propellants and Hagedorn-Plastic ma

14. ABSTRACT
STAR-ATO goal is to develop quickly transition-able technologies into improved weapon systems. Two propellant formulations were developed that met the desired velocity and pressure requirements of the 105mm M119 weapon and one Nitrochemie manufactured propellant was tailored to meet the MK44 goal of improved velocity over the current baseline propellant. Nitrochemie type propellants are tailorable for the M119 and MK44 weapon systems. Additional work is required to eliminate the residue issue experienced with the ARDEC type formulation which displayed improved gun performance.

15. SUBJECT TERMS
STAR-ATO; ECL Propellant; Flat Temperature Coefficient; Semi-Conductive Bridge Initiators; Progressive Propellant

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Final Report

For

New Propellant Formulation Development

Initiative No.: OTIA 6 2010-333 INIT-137

Reporting Period: March 2011- October 2012

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Attachments

1.0 Summary

The STAR ATO program goal is to develop technologies that can quickly transition into improved weapon systems. This effort was focused on 105 mm M119 and the 30 mm MK44 weapons. Both of these weapons have increased projectile weight compared to fielded systems. One way to improve the performance with weapons with heavier projectiles is to utilize a more progressive propellant.

An ARDEC formulation and a Nitrochemie propellant met the desired velocity and pressure requirements for the M119. The ARDEC formulation had significant slivers. The Nitrochemie propellant which had multiple iterations burned "cleaner" than the ARDEC formulation. Addition work on the ARDEC propellant may result in meeting or exceeding the Nitrochemie formulation.

The MK44 work tested Nitrochemie propellant against AFP002 (GAU 8) propellant. The Nitrochemie propellant had a significant velocity improvement over the base line propellant.

This contract vehicle was used by the government to purchase 3,528 lbs of and 150 Semi-Conductive Bridge Initiators (SCBI).

This contract vehicle was used by the government to purchase 4,720.76 lbs of Nitrocellulose, UN 2556, Nitrocellulose with Alkohol, 4.1, II from Hagedorn-Plastic in Osnabruck, Germany.

2.0 Introduction

The workhorse propellants in the U.S. Army's small, medium and large caliber munitions are all nitrocellulose-based. As the Army drives continuous improvement in both the quality and performance of its munitions, it is imperative that the latest characterization technologies be brought to bear on propellants and understanding the influence of nitrocellulose properties on propellant performance. Projectiles are getting heavier, ammunition is being exposed to higher temperatures, step changes in IM properties are required and environmentally friendly solutions are desired. With the advent of air burst ammunition and multipurpose warhead technologies, the performance envelopes for propellants are getting tighter. This effort will expand upon information learned in GYF09 INIT264 and GFY10-248 Improved Gun Propellant Performance.

In general, the objective of this project is to tailor current propellant formulations to meet the needs of today's war fighter. This can be accomplished by an increased understanding of current deterrent coatings, stabilizers, and propellant materials used in all types of propellants.

3.0 Methods, Assumptions and Procedures

This work can be separated into three primary areas of interest: testing, deterrent coatings, and propellant.

Phase I consisted of purchasing some essential parts and ingredients for ARDEC. The items purchased included igniter parts, low nitration nitrocellulose, nitrocellulose, DEGDN, 30 mm components, squeeze flow rheometer and a paper mill.

Phase II entailed small scale studies of new formulations by ARDEC and Nitrochemie. During Phase II propellant was manufactured and coated in small batches of approximately ten to fifteen pounds each. These small batches went through a variety of testing to gain an increased understanding of the materials under consideration as well as the refinement of the models.

Phase III moved selected formulations from Phase II to full scale processing. One production mix of the ARDEC formulation was manufactured which provided sufficient amount of propellant for gun testing.

Additional work was authorized with changes to the SOW. AMRDEC received the approval from ARDEC to use the remaining value of this contract to manufacture and deliver twenty-five solventless ASD grains to Huntsville. AMRDEC also added scope to this effort to manufacture 800 ASD grains for delivery in May.

Finally, ARDEC approved ATK to procure 4,720.76 lbs from Hagedorne in Germany for Army testing at Picatinny Arsenal. Delivery occurred in Oct 2012.

4.0 Results and Discussion

Iteration 1

Phase I

The following items were delivered to ARDEC:

- 125 Loaded Head Assemblies (P/N 12525144 Rev E) and 250 Primer body assy. (P/N 12525145, Rev C)
- Two drums of 12.2%N nitrocellulose
- Three hundred pounds of each of the below lacquer grade NCs

Product
DLX 3-5
DLX 30-50
DHX 3-5
DHX 30-50

- Squeeze Flow Rheometer
- Paper Mill
- 30mm components
    - 500 - PGU15 primed cases
    - 100 - PGU15 metal projectile bodies
    - 250 - PGU13 metal projectile bodies
    - 250 – MK266 metal projectile bodies
- 210 pounds of RXL 666 (DEGDN mixed with 15% acetone)

Phase II
The second lot of ECL propellant manufactured by Nitrochemie for the 30mm Airburst was tested during this quarter in a MK44 barrel at the ATK facility in Elk River Minnesota. The propellant description sheet is Attachment 1. The data is in Attachment 2.

The third lot of ECL propellant manufactured by Nitrochemie was delivered and tested in the 105mm artillery gun. The data description sheets are in attachment 3, Test Plan is in Attachment 4 and the data is in Attachment 5. The residue issues that were present for the first two iterations were resolved. However the temperature coefficient was pretty steep verses the desired flat coefficient.

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Phase III

The ARDEC PAP 10-002 formulation for 105mm Artillery was scaled up to the 100-gal sigma blade mixer. The work instruction and PDS are Attachment 6 and 7. The propellant was tested at Yuma with favorable results in August. The ballistic parameters were met, Attachment 8. There was slivering of the propellant which left residue in the barrel. A geometry adjustment should correct the issue. Unfortunately the facility competition prevented making a second lot of propellant.

Iteration II

AMRDEC had a need for some solventless propellant grains. Phase 1 was to prove out the concept with a delivery of 25 grains. Target geometry Phase 2 delivery was for 800 grains.

Phase I

AMRDEC request 25 grains and provided desired dimensions. ATK modified existing tooling to meet the targeted dimensions. The insert (TD112495) of 3-inch Grains Assembly Tooling (TD112496) was modified to the desired diameter allowing for some grain swell. A conservative approach was used keeping the OD slightly smaller than desired. The next Phase used the data gathered and opened up the insert to get closer to the final geometry. Die stake 54129 was used to provide the web.

N5 propellant lot RAD03B-071876 (PDS Attachment 9) was used in this effort, it was over run from a previous contract. A total of seventy-seven 24-inch grains were extruded to SWIQDC-1663 Attachment 10. The dimensions of the grains are attached: Attachment 11. Sixty three grains were delivered. AMRDEC obtained an IHC for the grains. The IHC is Attachment 12. A total of 63 grains were shipped to AMRDEC in February.

Phase II

The deliverable for Phase 2 was 800 grains. 8600 lbs of N5 lot number ARV12E-000S065 carpet roll was manufactured to QDC8266. The carpet roll was extruded to SWI-QDC1679 Attachment 13. The PDS and the SQC grain measurements are Attachments 14 and 15. A total of 903 grains were shipped in May and June.

Propellant SCBI Purchase

This Contract was used to transfer 3,528 lbs of JA2, 19 Perf Hex Granular Propellant. ATK had a total of 3591 lbs of Lot# ARV05D-072063 and transferred the entire lot to the US Government at no additional cost. 1,000lbs was shipped to Yuma Proving Grounds on 22 January 2013. The balance of the propellant was transferred in place and is located at American Ordnance LLC, Middletown, Iowa. The point of contact to arrange for the delivery of this propellant is Craig Aakhus (763-744-5477).

150 Semi-Conductive Bridge Initiators (SCBI) were shipped to ARDEC. 130 on 24 Jan 2013 and 20 on August 2012.

4, 720,76 lbs of NC with Alcohol was delivered to ARDEC on Oct 2012 to the attention of Mohamed Elalem.

5.0 Conclusions

The ARDEC formulation was scaled-up to a production mixer. The gun performance was favorable but requires geometry modification to eliminate residue. The Nitrochemie propellants are tailorable for the MK199 and MK44 weapons.

6.0 Recommendations

Conduct additional work on the ARDEC formulation to eliminate the residue